A.7: EPICS Based Control System for Microtron

The control software for Microtron was recently upgraded by Accelerator Control section. The Labview based control software has now been replaced by EPICS based control software. Experimental Physics and Industrial Control System (EPICS) is a set of open source software tools and applications that provide a software infrastructure for building distributed control systems, and is used worldwide to operate devices such as Particle Accelerators, Large Experiments and major Telescopes. EPICS use Client/Server and Publish/Subscribe techniques to communicate between the various computers. The servers (called Input/Output Controllers or IOCs) perform real-world I/O and local control tasks, and publish this information to clients (Operator Interfaces or OPIs) using the Channel Access (CA) network protocol. CA is specially designed for the kind of high bandwidth, soft real-time networking applications. The home-grown VME infrastructure at RRCAT, along with LabVIEW was used earlier for the Microtron. Increasing demands and continuous evolution of the system entailed upgrade of the control system. The new system offers better SCADA performance, is easily scalable for future high performance requirements and offers possibility of efficient communication across various controllers in a uniform, distributed system to enable feedback systems in future.

There are about 150 parameters (Process Variables or PVs) of the system to be administered by EPICS. The lowest layer consists of equipment controller, a VME station (consisting of Motorola 68K CPU, ADC, DAC, Relay and Opto in boards), acquisition devices such as Oscilloscope, Teslameter and temperature scanner and other instruments like RF synthesizer. The VME CPU runs an assembly program that handles standardized commands for interfacing with VME I/O boards. Other devices are handled by the standard manufacturer specified control commands. The middle layer is the Input-Output Controller (IOC). It is a Linux PC running Ubuntu 8.10 that links to the lowest layer instruments and acquisition devices on RS-232 and TCP/IP. The IOC was framed on EPICS base version 3.14.9. The record support was built using base 3.14.9. The IOC is used to process the raw data and publish it in the form of PVs to be used by the EPICS clients. The error checking modules and event based processing of data have been incorporated in IOC. The upper layer is the Operator Interface; it is a Linux PC running Ubuntu 8.10 that runs CA clients (Fig. A.7.1) designed in EDM 1-11-0z. The OPI connects to the IOC on 10 MBPS Ethernet on Channel Access protocol. It shows the readback status of power supplies, interlocks, temperatures, vacuum, magnetic field etc, and control widgets for analog setting and ON/OFF control of devices. Other functionalities for user authentication, default settings, cycling of magnet, device status and help were also provided.

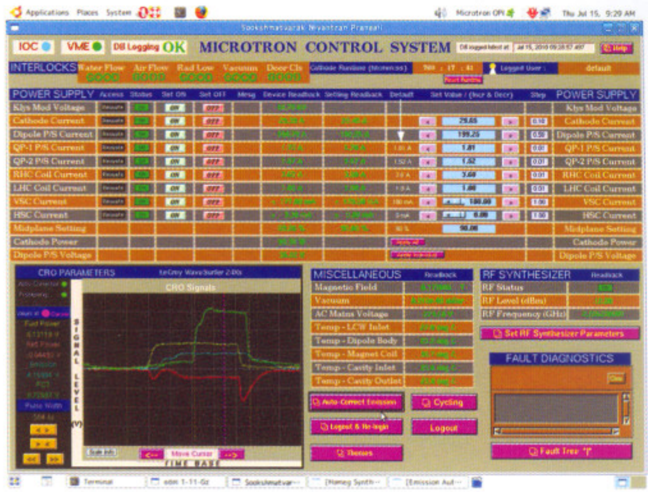

Fig. A.7.1: The Microtron Control GUI developed in EPICS

A fault diagnostic module and emission auto-correction was also provided. The offline fault diagnosis module predicts anomalies in the system behavior and eases fault troubleshooting. The cathode emission auto-correction is a closed loop control for controlling electron emission from the cathode. The alarm handling consists of reporting the alarms at the user interface and trip alarm calculation and generation at the IOC database. The data logging is done and data is logged in the central Microsoft SQL Server based database.

Employing EPICS proves beneficial than commercial SCADA. The EPICS IOC servers can talk to each other and can access each other's PVs over Ethernet. Hence, future expansion to other systems will make the whole system integrated. EPICS has modular architecture. As EPICS is free and open source, it provides a cost effective upgrade on control software. A huge community support is available for EPICS.

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A.8: Indus-1 Beamlines Gate Valve Authorisation system

The Gate valve authorization system was recently commissioned by Accelerator Control Section in Indus control room. This system is employed to give permission for opening gate valve GV0 to beam line users. GV0 is the valve isolating Indus-1 ring from a Beam line. The authorization is given from control room. This was done to implement this procedure in a coordinated manner and avoid accidental venting of the ring on opening GV0, in case the beam line vacuum level is not appropriate. Also, the control room will have full information, e.g., which beam line is used and since when. Before installation of this system, the gate valves were opened by respective beam line people as per their requirement of beam.

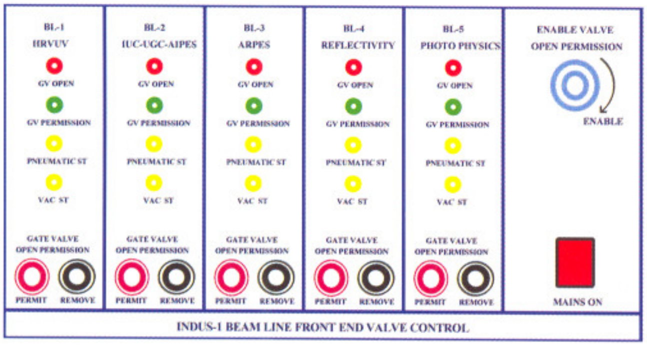

Fig. A.8.1: Master Control Unit

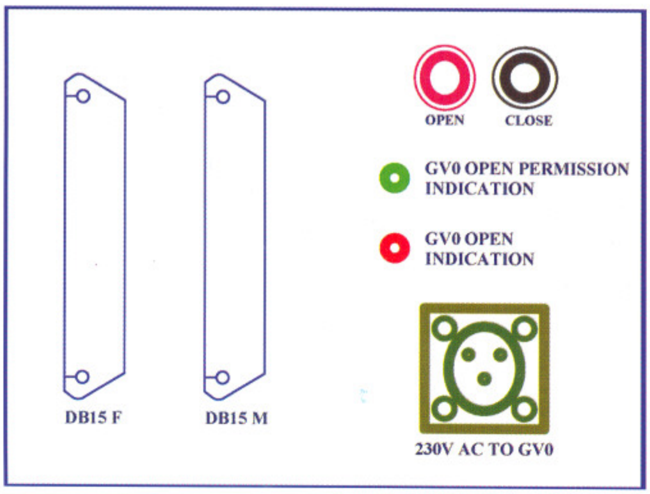

Fig. A.8.2: Field Control Unit

A single master control unit (Fig. A.8.1) in the control room and one field control unit (Fig. A.8.2) per beam line constitute the system. The master control unit is placed in Indus control room and fed from control room power. It has push buttons to give GV0 open permission as well as to remove permission, and indicators to show status of permission, status of GV0 (OPEN/CLOSE), pneumatic pressure good status and Vacuum good status. The permission is to be given by shift in charge after ascertaining proper vacuum level at the beam line. For this purpose, provision of vacuum interlock is also given. A key-lock switch has been provided whose key remains in control of the shift in charge. Key is to be inserted and key switch to be turned to permission enable position, for giving valve open permission using push button. After giving permission, the key has to be removed from the switch. The Valve can then be opened from field control unit by pressing the open button. Permission can be removed from control room, by 'Remove Open Permission' button provided. It can be done even in absence of key in the switch. GV0 can also be closed from field side, using GV0 close button. In both the cases, GV0 open permission would also be withdrawn. GV0 open permission is to be given every time before GV0 can be opened.

The field control unit near each beam line is given AC mains locally at each beam line. Its supply has to be ON before GV0 open permission is given from control room. Open and close push buttons were provided on the unit for opening and closing of GV0 valve. Indicators are also provided to indicate GV0 status and permission status.

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A.9: Indus-1 LCW Plant Control System Automation

Low Conductivity Water (LCW) is the cooling agent, which has been used for cooling of magnets, Power supplies, RF cavities and different equipments used in the accelerator complex. The LCW plant for Indus-1is used for the production, cooling and supply of this chilled LCW to different subsystems like Power supply and RF amplifiers of Booster, Indus-1 ring, TL1 and Microtron. This plant had been operated manually since the commissioning of the Indus-1.

Recently automation of Indus-1 LCW plant has been completed to facilitate the remote control and monitoring of the plant as well as to log and monitor the process parameters like water temperature, flow, pressure, conductivity, level and other data for easy diagnostic of faults and malfunction of equipments. The control system for LCW plant was developed by Accelerator Control Section.

The control system of Indus-1 LCW plant has been realised using VME bus based data acquisition system with two VME Equipment Control Stations (ECS) (Fig. A.9.1). The ECS have been placed in the LCW plant area. One station is used for interfacing of about 350 status input signals and 100 output control signals. Second station is used for interfacing about 200 analog inputs. The local operation of different electrical valves has been provided using the valve controllers. The valve controllers were provided on the wall mounted terminal panels situated at five different locations (service block area, cooling tower area, microtron area, booster area, storage ring area and power supply area). Software reconfigurable interlocks have been exercised for all motors.